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Homogeneous Nucleation of Nanoparticles from Supersaturated Vapor Investigated by In-situ IR Measurement Experiment

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When we evaporate experimental materials in the atmosphere, nanoparticles condense from highly supersaturated vapor via homogeneous nucleation. This technique is known as the Gas Evaporation method. Nuclei must overcome energetic disadvantage of surface by making chemical bonds to form particles. Since energetic barrier for homogeneous nucleation is excessively high, homogeneous nucleation occurs from highly supersaturated vapor [1-3]. In such conditions, precursors should grow following kinetically feasible reaction path, which is deviated from equilibrium condensation. Furthermore, the size of nuclei is so small that they show quite different physical and chemical properties from that of bulk material. Therefore, chemical reaction processes and its properties during transition state of homogenous nucleation are still unrevealed.

For the purpose of examination of condensation sequences of nanoparticles, we investigated by a new experimental apparatus named Free-flying *In-situ* infrared measurement of Nucleating nanoparticles Experimental (FINE) system [4]. FINE system is for gas evaporation method combined with FT-IR and enables direct *in-situ* IR measurement of condensation of 10-100 nm nanoparticles via homogeneous nucleation from vapor.

We applied FINE system for silicate and titanium oxides and revealed that condensation proceeds through metastable phases with non-crystalline IR feature, which is known as Ostwald's step rule. Just condensed nanoparticles would be liquid droplet and crystallization proceeded subsequently. In previous study, we succeed in measurement of IR evolution after nucleation. However, the information about precursors is still lack to understand condensation mechanism. We are now developing a new experimental set up for FINE system and going to talk about future work.

References

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